INSTRUCTION MANUAL FOR

MODEL # 206

0-30 KV DC HIGH VOLTAGE POWER SUPPLY

SERIAL # 374

BETA ELECTRIC CORP.
NEW YORK, N. Y.

4546

2096

NOTE:

Please read the entire instruction manual thoroughly before attempting to operate the unit.

If this is not convenient, please read the operating instructions completely before applying power for the first time.

OPERATING INSTRUCTIONS

AND

SERVICE NOTES

for

SERIES 201

PORTABLE HIGH VOLTAGE DC POWER SUPPLIES

0 to 30 KV DC

* * *

MODELS 201, 202, 203, 204, 205, 206

and —M1, M2,/R designs

BETA ELECTRIC CORP.

333 EAST 103rd STREET

New York 29, New York

Designers and custom builders of High Voltage Power Supplies; Kilovoltmeters; Electronic Rheostats; Portable Projection Oscilloscopes Electronic Microammeters and Industrial Electronic Equipment.

Sept. 1951

WARRANTY

This power supply is guaranteed against all defects of workmanship or material, with the exception of rectifier tubes, (on which no guarantee is given) for a period of 1 year after date of shipment,

PROVIDED that the guarantee card for the power supply, sent with the unit, has been properly filled out and returned to us.

For units requiring service after the warranty period, the power supply may be returned to the factory without prior authorization. Repairs will be made at nominal charges for parts and labor.

SPECIFICATIONS

for Models 201 through 206, 201-M1 through 206-M1 and 201-M2 through 206-M2

Portable 0-30 KV DC Power Supplies

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INPUT

100-130 volts (117 volts nominal), 50/60 cycles, 200 voltamperes, maximum.

* * * * *

OUTPUT

Voltage: Continuously variable from 0 to 30,000 volts DC.

Current: 2 milliamperes maximum (determined by rectifier rating).

Models 201, 202 and 203 — Approximately 400 microamperes at 30 KV.

Models 204, 205 and 206 — Approximately 1.8 milliamperes at 30 KV.

Polarity: *Models 201, 204* — High voltage positive (negative grounded).
Models 202, 205 — High voltage negative (positive grounded).
Models 203, 206 — Reversible high voltage polarity (low grounded).
(*NOTE:* Ground refers to power supply cabinet.)

Regulation: *Models 201, 202, 203* — Internal resistance approximately 4 megohms. (Not stabilized against line voltage variations.)
Models 204, 205, 206 — Internal resistance approximately 3 megohms. (Not stabilized against line voltage variations.)

Ripple: (60 Cycle Input)
0.3% with external load of 1000 megohms.
0.6% with external load of 100 megohms.
3% with external load of 10 megohms.
25% with external load of 1 megohm.

Filter Capacitance: 0.005 mfd. in series with 1 megohm protective resistance, in parallel with high voltage output cable capacitance (150 mmf., approx.) and in parallel with load capacitance (if any).

AUXILIARY CIRCUIT FEATURES

METERS:

Models 201 through 206:

(1) *output voltage;* 0-30 Kilovolts DC; 2½" round case; Initial accuracy 2.5%.

(2) *covat* current;* 0-2 Amperes AC, 2½" round case; 3% accuracy.

Models 201-M1 to 206-M1:

(1) *output voltage;* 0-30 Kilovolts DC; 2½" round case; initial accuracy 2.5%.

(2) *load current;* 0-2 milliamperes DC; 2½" round case; 3% accuracy.

Models 201-M2 through 206-M2:

(1) *output voltage;* 0-30 Kilovolts DC; 2½" round case; initial accuracy 2.5%.

(2) *load current;* 0-200/2000 microamperes DC; 2½" round case; 3% accuracy.

CONTROLS:

1.—FILAMENTS ON toggle switch.
2.—HIGH VOLTAGE HOLD pushbutton.
3.—HIGH VOLTAGE LOCK pushbutton.
4.—HIGH VOLTAGE OFF pushbutton.
5.—OUTPUT VOLTAGE CONTROL COVAT*.
6.—(Models 203 and 206 only) DC meter polarity reversing switch.
7.—(M2 designs only) Load current meter range selector switch.

* Covat — COntinuously Variable Auto Transformer; i.e., Variac, Powerstat, etc.

PILOT LIGHTS:

1.—FILAMENTS ON clear neon pilot light.

2.—HIGH VOLTAGE ON red neon pilot light.

3.—(Models M1 and M2 only) Clear neon pilot light to indicate meter overload.

FUSE PROTECTION: 2 amperes.

SIZE: (1) Cabinet — 16″ high x 16″ wide x 9″ deep. Add 2″ height for carrying handle, 1½″ depth for control knobs, ¾″ width for ground post.

(2) Relay rack panel mounted (Models /R); Panel 19¼″ x 19″ high, depth behind panel 9½″.

WEIGHT: (1) 40 pounds.
(2) Relay rack panel mounted (Models /R); 46 pounds.

CONNECTIONS: (1) Low Voltage — 2 pronged recessed male receptacle, 125 V, 10 A; Suitable 6′ long line cord provided with the power supply.

An auxiliary 2 pronged outlet is provided in parallel with the input plug. (This may be rewired for an interlock or an external shorting mechanism. See Application Notes 3 and 4.)

(2) High Voltage — A 6 foot long, polyethylene insulated shielded cable, with a rubber covered battery clip (permanently connected), from right, rear bottom.

GENERAL:

The Beta Electric Corp. Series 201 Portable 0 to 30,000 volts DC power supplies, utilizing rectified 50 or 60 cycle power, are compact, extremely reliable power supplies, specifically designed for low current, high voltage applications. Approximately 400 microamperes may be drawn at 30 KV from Models 201, 202, and 203 power supplies, and 1.8 MA at 30 KV in the 204, 205, 206 models.

The maximum permissible drain, as determined by the rectifiers' rating, is 2 milliamperes average, being available below approximately 24 KV in the Models 201, 202 and 203, and approximately 28 KV in the Models 204, 205 and 206. All other circuit components are conservatively rated for considerably more than 2 MA load at 30 KV.

The power supplies are complete instruments, designed for rugged industrial use, including continuous operation at maximum rated output voltage and current, and for exacting research work. Such important features, as dual pushbuttons for permanent high voltage switching, are indicative of the safe design for use by untrained personnel on a factory production line. The use of a "holding relay" for the high voltage primary power precludes the possibility of damage to electrical components undergoing life test, if the line power should fail momentarily and then return, when the equipment is unattended.

These power supplies employ a full wave voltage doubler circuit, permitting the use of components considerably lower in voltage rating than required in a full wave or half wave single stage rectifier of equivalent voltage output. The high voltage transformer is rated at 11.5 KV rms, and the rectifiers are subjected to an inverse voltage approximately equal to the actual output voltage. Thus, with rectifiers rated at 40 to 60 KV inverse, there is an ample margin of safety at an output voltage of 30 KV. (40 KV rating in Models 201, 202, and 203; 60 KV rating in Models 204, 205 and 206.)

The high voltage filter capacitors contain plastic dielectric materials of high breakdown rating, reducing the size and weight considerably over capacitors of the same rating utilizing paper or similar dielectric materials.

A unique filament transformer design, developed by the Beta Electric Corp., results in a lightweight, air-insulated unit with filament windings rated for more than 40 KV DC insulation with respect to the core and to the other windings. Without this lightweight, multi-winding high voltage filament transformer, a portable, rectified 60 cycle, 0 to 30 KV DC power supply would not be practical.

In the Models 201 to 206 power supplies, the output DC voltage is metered, as is the covat* output current. This latter meter is valuable as a general purpose trouble-shooting device. The ammeter will indicate whether there are any shorts in the power supply or in the load circuit, by reading off-scale with only a few volts output from the covat. The meter will read lower than normal in case of open circuit.

In the series M1 and M2 power supplies, a load current meter is substituted for the covat current meter. The load current meter is at ground potential, indicating all leakage and corona current, as well as load currents. Models M1 employ a single range meter; Models M2 provide two load current ranges.

In the Models 201 and 204, the high voltage DC polarity is fixed, positive with respect to the cabinet (ground). In the Models 202 and 205, the high voltage polarity is fixed, negative with respect to the cabinet. In the Models 203 and 206, the high voltage polarity with respect to the grounded case may be either positive or negative, as desired. Polarity reversal is effected by reversing the sense of rectification of the two rectifier tubes; the positions of two leads inside the power supply are interchanged for this reversal.

For added operating convenience, the control panel has been made removable from the high voltage circuits proper. The panel wiring is connected to the remainder of the circuits through a cable connector pair. When the panel is removed, it is necessary only to run an extension cable of the desired length from the control panel to the high voltage circuits. The extension cable can be well over one hundred feet in length without affecting the operating properties of the power supply.

* Covat — see note Page 3.

CIRCUIT DETAILS:

(a) CONTROL CIRCUITS (all Models)

Referring to the accompanying schematic circuit drawing, Fig. 1, the operation of the control circuits of the power supply can be understood. The controls are the same for all models. (In the -M1 and -M2 models, the COVAT CURRENT meter M1 is not present.)

J1 is a two-pronged recessed male connector, located on the left-hand side of the cabinet, as viewed from the front, through which the power supply is connected to the 117 volt mains by means of a line cord provided with the power supply.

J2 is an auxiliary 117 volt outlet, located adjacent to the input connector, energized when J1 is energized, that may be used for such equipment as an oscilloscope, soldering iron, etc. It can also be used for an external safety interlock, or for an external output shorting mechanism. (See Application Notes 3 and 4.)

F is a fuse for general protection. BP is a binding post labelled ALWAYS OPERATE WITH GOOD EXTERNAL GROUND, located near J1, and tied electrically to the cabinet. This should always be connected to a good external ground before the power supply is plugged into the 117 volt source.

Toggle switch S1 energizes the filament transformer T2, and pilot light I1 FILAMENTS ON. Resistor R4 is a ballast, for proper filament voltage rating. It is seen that the filaments are energized with rated voltage at all times, independent of the output DC voltage.

Depressing S3, the pushbutton labelled HIGH VOLTAGE HOLD, energizes the covat* T1 and, accordingly, the primary of the high voltage transformer T3. When S3 is depressed, the HIGH VOLTAGE ON pilot light, I2, is illuminated. When S3 is released, the covat is de-energized. Thus, S3 must be held depressed for high voltage.

If it is desired to have the high voltage continuously on, then, when S3 is depressed, it is necessary to depress simultaneously pushbutton S4 labelled HIGH VOLTAGE LOCK. This energizes the relay K1, shorting out pushbuttons S3 and S4 by means of two normally open contacts 1a and 1b on the relay K1. The relay is now held in automatically, and the pushbuttons may be released; the high voltage will remain on.

To de-energize the high voltage when it has been "locked in," the red pushbutton labelled HIGH VOLTAGE OFF, S2, must be depressed. This opens up the normally closed contacts, and causes the relay to drop out, thus opening contacts 1a and 1b, removing covat power.

The "holding relay" K1 ensures permanent removal of high voltage power if the line voltage should fail momentarily. With loss of line power for as short a period as 2 cycles, the relay will drop out, opening contacts 1a and 1b, and removing power from the covat primary.

Capacitors C1 and C2 constitute a line filter to reduce feedback of corona generated rf noise to the power mains from the high voltage circuits.

Meter M1, COVAT CURRENT, monitors the input current to the high voltage transformer T3. In case of a short circuit in the high voltage components or load, M1 will read higher than normal. If a circuit element is open, M1 will read lower than normal. Normal reading is about 0.4 amperes at no load and 30 KV output.

NOTE: The covat current meter M1 is omitted in the -M1 and -M2 designs. A DC load current meter is employed, located as discussed below.

(b) HIGH VOLTAGE CIRCUITS:

I — Models 201, 204:

Referring to Fig. 1, the high voltage doubling circuit consists of transformer T3, capacitors C3a and C3b, and rectifiers V1 and V2, connected as a full wave voltage doubler**, for positive high voltage.

R1 is a protective resistor to limit the value of the initial surge of current in the output circuit, in case of arc-over or failure of a component subjected to the high voltage. (See Application Note #7.)

R2 acts as a bleeder across the high voltage capacitor, and as the voltmeter multiplier. Meter M2, OUTPUT VOLTAGE, serves as the output voltage indicating meter. R3 calibrates M2 for full-scale deflection with 30 KV DC output.

It should be noted that the output kilovoltmeter is connected directly at the output lead; therefore no correction need be made to the kilovoltmeter reading for the IR drop across the protective resistor R1.

II — Models 202, 205:

The High Voltage circuit is identical to that discussed above, except that rectifiers V1 and V2 are reversed in sense, producing high voltage negative with respect to ground (or positive) case. This is shown in Fig. 2.

III — Models 203, 206:

Output voltage polarity reversal is effected by interchanging the plate connection of V2 and the cathode connection of V1 in the high voltage circuit, as shown in Fig. 3. In the schematic diagram, the crossed lines (++) represent the connections for positive high voltage polarity, and the dashed lines (— —), the connections for negative high voltage polarity.

Switch S5, METER POLARITY SELECTOR, is a double pole, double throw rotary snap switch that reverses the polarity of the output voltage indicating meter M2, to correspond to the high voltage polarity.

* See note Page 3.

** D. L. Waidelich, "The Full Wave Voltage Doubling Rectifier Circuit," Proc. of I. R. E., Oct., 1941, pp. 554-558, inc.

IV — Models 201-M1, 204-M1:

In the -M1 units, a DC load current meter, 2000 microamperes full scale, is placed in the ground return lead of the high voltage recifiers' circuit, as shown in Fig. 4. This is M1, labeled OUTPUT CURRENT, replacing the covat current meter. In this connection the meter will read the average DC load current since no *average* DC can flow from capacitor C3 at the steady state. The DC load MUST be flowing through the rectifier. With this connection, the load current meter indicates all of the corona current and leakage current in the power supply as well as the actual load current.

In order to protect the meter against current curges, a resistor R5 is included in series with the meter, with a neon pilot light I3 across the combination. I3 fires when the load current exceeds approximately 1.5 times the full scale reading of the meter, and any increase in current will flow through the pilot light, thus protecting the meter. Capacitor C4 ensures firing of I3 on average current, rather than on the peak rectifier currents that flow.

NOTE: The return of M2 is not to ground but to the high end of M1, so that the load current meter does not register the kilovoltmeter current. This connection introduces a kilovoltmeter error of approximately 50 volts at 2 MA load. This is negligible in almost all applications of the series 201 units, and is well below the readable limit of the meter scale.

V — Models 202-M1, 205-M1:

The high voltage circuits as shown in Fig. 5, are identical with the 201-M, 204-M, except that the rectifiers' sense is reversed.

VI — Models 203-M1, 206-M1:

Polarity reversal and other features are as per Models 203 and 206. However, S5 as shown in Fig. 6, is a 4-pole, 2 position shorting type rotary selector switch, to reverse the sense of both M1, the load current meter, and M2, the output voltage indicating meter.

VII — Models 201-M2, through 206-M2, inclusive:

These models have a 2-range output current meter, 200 and 2000 microamperes, DC full scale. With this design, a load current of 5 microamperes can be measured, so that at 30,000 volts, direct $\frac{E}{I} = R$ measurements of resistance up to 6×10^9 ohms, or 6,000 megohms, can be made without the use of external microammeters.

The basic movement of M1 is 200 microamperes, so that the single pole toggle switch S6, OUTPUT CURRENT METER RANGE, is needed to throw in the shunting resistor R6, in the "2000" position.

The connections of S6 and R6 for Models 201-M2 and 204-M2 are shown dotted in Fig. 4. Similarly, in Fig. 5 for 202-M2, 205-M2. S6 and R6 are shown in Fig. 6 for 203-M2 and 206-M2.

OPERATING INSTRUCTIONS

(ALL MODELS)

1.—GROUND THE POWER SUPPLY BY MEANS OF THE BINDING POST, PROVIDED FOR THIS PURPOSE, ON THE LEFT SIDE OF THE CABINET.

2.—Connect the line cord to a 117 volt 60 cycle outlet, and plug into the recessed receptacle on the lower left hand side. This will simultaneously energize the two pronged outlet, which may then be used for any auxiliary equipment up to 10 amperes, 117 V AC rating.

3.—Throw the FILAMENTS ON toggle switch to ON. This energizes the rectifier filaments, and illuminates the FILAMENTS ON pilot light. No warm-up time is needed, as the rectifier cathodes are directly heated.

4.—TURN THE "HIGH VOLTAGE CONTROL" TO ZERO.

5.—Depress the HIGH VOLTAGE HOLD pushbutton; this energizes the covat* and illuminates the HIGH VOLTAGE ON pilot light. Turn the covat control clockwise and read the output voltage on the output voltage meter.

6.—TO MAINTAIN HIGH VOLTAGE WITHOUT HAVING TO KEEP THE "HIGH VOLTAGE HOLD" pushbutton depressed; proceed as in steps (4) and (5). When the HIGH VOLTAGE HOLD button has been depressed, hold it in, and depress the HIGH VOLTAGE LOCK button. Both switches may now be released, and the high voltage control manipulated to yield the desired output voltage.

7.—TO DE-ENERGIZE THE HIGH VOLTAGE WHEN THE CONTROLS ARE LOCKED IN, depress the HIGH VOLTAGE OFF red pushbutton.

8.—Throw the toggle switch to OFF, after de-energizing the high voltage, to turn off permanently.

* See note Page 3.

9.—POLARITY REVERSAL: Two wires as shown heavily in the rear view of the power supply, Fig. 7, must be properly placed for positive or negative high voltage. These two wires terminate in banana plugs, and are put into suitable jacks connected to ground and the high voltage capacitor C3b.

(a) POSITIVE HIGH VOLTAGE (negative ground):

The two wires must be connected as shown solid, in Fig. 7.

i.e. (1) From the plate cap of V2 to the ground, or right, plug.

(2) From the cathode of V1 to the high voltage, or center, plug.

(b) NEGATIVE HIGH VOLTAGE (positive ground):

The two wires must be connected as shown by the broken lines in Fig. 7.

i.e. (1) From the plate cap of V2 to the high voltage, or center, plug.

(2) From the cathode of V1 to the ground, or right, plug.

10.—METER POLARITY SWITCH: Set the polarity selecting switch on the control panel to either (+) or (—), as per the high voltage polarity.

* * * * *

ALL M2 MODELS:

11.—LOAD CURRENT METER:

In addition to the above steps, the load current meter range switch S6 must be set at either "200" or "2000" depending upon the magnitude of load current expected.

* * * * * * * * * *

PRECAUTIONS

1.—ALWAYS OPERATE WITH A GOOD EXTERNAL GROUND.

For convenience, a terminal post connected to the case is provided at the lower left side of the case. This precaution will prevent high voltage from appearing on the cabinet unexpectedly, in case of load or component failure. Make this connection before energizing the power supply.

2.—NEVER HANDLE THE OUTPUT LEAD WITH VOLTAGE ON.

Although a protective resistor is included in the output circuit to limit the short circuit current to a harmless value, nevertheless, an extremely unpleasant shock may be experienced if contact is made with the exposed end of the output lead. It is suggested that the output clip be connected to the ground post after use of the power supply. If the load has a capacitance more than 0.005 mfd., then great precautions must be taken to avoid contact with the load at voltages above 10 KV.

3.—TURN THE "HIGH VOLTAGE CONTROL" TO ZERO AFTER USE.

This precaution will obviate the possibility of unexpected high voltage appearing in circuits, and possibly injuring external equipment when the power supply is again turned on.

However, application of full high voltage suddenly will not injure the power supply. (See Application Note #6.)

4.—IF THE OUTPUT DOES NOT REACH 30 KV AT NO LOAD,

check that the high voltage reversing leads are properly inserted for either positive or negative high voltage, as required (Models 203 and 206 only).

5.—DO NOT DRAW MORE THAN 2 MA DC from the power supply, at ANY output voltage.

The rectifiers are rated at 2MA DC maximum average current; drawing more current will shorten the life of the tubes noticeably. Since the rectifiers are connected in a full wave doubling circuit, each rectifier has the full average load current flowing through it, not ½ the load current, as in an ordinary full wave rectifier circuit.

6.—WITH LINE VOLTAGE LESS THAN 100 VOLTS,

do not operate at voltages above 10 KV and currents above 1 MA simultaneously. The decreased rectifier heating voltage at low line voltage will result in excessive tube drop and deterioration of the cathode. At light loads, less than 250 microamperes, the output voltage may be 30 KV with 100 volts input.

7.—DO NOT OPERATE WITH LINE VOLTAGE MORE THAN 130 VOLTS

for extended periods of time, as the rectifier life will be shortened noticeably.

APPLICATION NOTES

1. — OPERATION WITH FIXED LOAD:

If the power supply is to operate for a long period of time with fixed load, then it is recommended that the 2 ampere fuse normally provided with the power supply be replaced by one of small rating. This rating should be equal to the fixed load of approximately ¼ ampere (due to the pilot lights, covat exciting current and relay coil current) plus the transformed value of the covat secondary current, as read on the covat output current meter.

This precaution will assure rapid blowing of the protective fuse in case of partial or total failure of some component in the high voltage circuit, or shorting of the load. If the supply is overfused, a partial failure of a component or a load short may not blow the fuse, and operation under the partial overload condition may result in consequent burnout of a tube, resistor, or transformer, or shorting of the doubler capacitor. Because of possible starting current surges, it is suggested that a "Slo-blo" fuse be used, for this application.

2. — REMOTE OPERATION:

To operate the power supply at a distance from the control panel, remove the panel from the cabinet by unscrewing the six self-tapping holding screws on the panel. (The line cord should be unplugged.) Pry apart the cable connectors that connect the components on the panel to the components in the cabinet proper. Mount the panel as required in the new control position.

Wire up a cable of suitable length with a suitable male cable connector at one end, and a corresponding female at the other. The maximum permissible length of the cable is determined by the acceptable additional regulation due to line drop. Since the maximum line current is approximately 1.5 amperes, a typical multiconductor cable of 7 conductors, with #20 wire, will result in less than 10% additional regulation for a length of 300 feet.

The panel is interconnected with the cabinet by means of a common grounding wire in the cable. Therefore, if the cabinet is properly grounded, the panel need not be grounded separately. However, taking the additional precaution of separately grounding ALL exposed metal surfaces not mechanically bonded, is very good practice when working with high voltages.

3. — SAFETY INTERLOCK:

Where the power supply is being used in conjunction with a high voltage test jig, it is frequently desired to interlock the jig cover and power supply, so that the high voltage cannot be applied unless the jig cover is closed. The auxiliary outlet J2 can be readily adopted for external interlocking purposes.

(I) Controlling High Voltage Excitation by External Safety Interlock:

Referring to Fig. 1, if J2 is disconnected from J1 and placed in series with the short strip of wire running from S3 to the HIGH VOLTAGE ON pilot light I2, the relay will be energized, but the covat will not be energized unless an external short is placed across J2. This short can consist of a microswitch actuated by closing the cover of the test jig, or by a similar device.

To effect the change: (Refer to the appropriate detailed wiring diagram, Fig. 8a or 8b, and the corresponding panel detail drawing, Fig. 9a or 9b.

(a) Remove the front and rear panels.

(b) Loosen the four screws that hold the filament transformer to the cabinet base.

(c) Remove completely the two wires (3 and (4), running from J1 to J2.

(d) Loosen the two cable connector covers, and run wires from the lugs of J2 to pins (9) and (10) on the female cable connector.

(e) On the control panel, disconnect the two ends of the wire coded with "Quik-Label" #8. This wire runs from the lower right lug on S4, the HIGH VOLTAGE LOCK pushbutton, to the lower lug on I2 the HIGH VOLTAGE ON pilot light (See Fig. 9A or 9B). Tape up loose ends.

(f) Run a wire from pin (9) on the male cable connector to that lug on S4 from which wire #8 was removed, the lug to which wires 6 and 7 go.

(g) Run a wire from pin (10) on the male cable connector to that lug on I2 from which wire #8 was removed, the lug to which wire 9 goes. Tape up the loose ends of wire #8.

(h) Screw the filament transformer back into place; replace the cable connector covers and plug in the two connectors. Replace the control panel and the rear panel.

J2 has now been wired in series with the parallel combination of the HIGH VOLTAGE ON pilot light I2 and the covat primary. Unless J2 is shorted, I2 will not shine when S3, HIGH VOLTAGE HOLD, is depressed.

This arrangement of J2 permits the relay K1 to remain actuated when the interlock is open. Thus, once the high voltage has been locked in, *the output will be controlled by the jig interlock.* When the sample under test is put in place, and the jig cover closed, the high voltage will come on automatically when the jig cover closes the microswitch (or other interlocking switch). The high voltage is automatically removed (though not shorted) when the jig cover is opened.

It should be recognized that this method of testing is somewhat hazardous as no automatic output shorting is used. The natural decay rate of the output voltage has a time constant of approximately 1 second. Thus, after 2 seconds, the output voltage is still about 10% of the initial voltage. If the initial voltage is above 15 KV, the residual charge is sufficient to produce a noticeable, though very mild, shock. With no external capacitance, the power supply is essentially fully discharged after 6 seconds maximum.

(II) Controlling Holding Relay with External Safety Interlock:

If it is desired to "unlock" the high voltage when the external interlock is opened, then follow steps (a) through (d) listed above. Then (e) Remove the wire with the Code #4. This wire goes from the lower right lug of S3, the HIGH VOLTAGE HOLD pushbutton, to the lower right lug of S2, the HIGH VOLTAGE OFF pushbutton. In step (f) run the wire to S3; in step (g), to S2.

With this connection, the interlock is in series with the pushbuttons S3 and S2, and unless the external interlock is closed, no power can be applied to the relay or the high voltage circuits. If the relay has previously been "locked in," opening a jig cover interlock will automatically cause the relay to drop out, requiring deliberate resetting of the two pushbuttons S3 and S4 *with the interlock closed,* before high voltage can again be attained.

4. — AUTOMATIC OUTUT SHORTING:

J2 can be used to energize an automatic output voltage shorting mechanism. Thus if J2 were connected in parallel with I2, line voltage would appear at J2 when high voltage is on, and would be removed when high voltage is off.

This power could actuate a solenoid that removes a short from the output. When the power is removed from the solenoid, the solenoid plunger dropping out can short the output, bringing the high voltage DC inside the power supply and across the test specimen, rapidly to zero.

To connect J2 for such operation, it is necessary to move the lead, shown in Fig. 1 as going from the top of J2 to the top of J1, to the upper side of the covat input or I2. To effect this change (refer to the appropriate detailed wiring diagram. Fig 8a or 8b, and the corresponding layout diagram, Fig. 9a or 9b.

(a) Remove the front and rear panels.

(b) Loosen the four screws that hold the filament transformer to the cabinet base.

(c) Remove completely wire #3 going from J2 to J1.

(d) Run a wire from the now vacant lug on J2 to pin (9) of the female cable connector.

(e) Run a wire from pin (9) of the male cable connector to that lug on the HIGH VOLTAGE ON pilot light I2 that has the wire with code #8, the LOWER pilot light lug.

(f) Follow instructions (h) from page 8.

Now, when the primary of the covat is energized, J2 will also be energized with line voltage. Thus, power is available to operate a solenoid or other mechanism that automatically shorts out high voltage when the HIGH VOLTAGE OFF pushbutton, S2, is depressed, or when S3, the HIGH VOLTAGE HOLD pushbutton, is released.

5. — KILOVOLTMETER ACCURACY

The initial accuracy of the kilovoltmeter is better than 2.5% of full scale over the entire kilovoltmeter range. The kilovoltmeter multiplier has an inherent temperature coefficient that will cause a drift of indication equal to approximately 1.5 KV, if the output is maintained at 30 KV continuously.

At output voltages below 24 KV, the heating effect on the multiplier is almost negligible. Therefore, at voltages below 24 KV the output kilovoltmeter indication may be taken as quite accurate. For close readings above 24 KV, if the power supply is operated continuously at the high voltage, a more accurate kilovoltmeter, such as the Beta Electric Corp. Model 102, should be connected across the output. An alternative is to apply a correction of approximately 1.5 KV to the reading at 30 KV. The power supply kilovoltmeter will read high.

6. — CAPACITOR TESTING:

If the series 201 power supply is used for testing capacitors for high voltage breakdown, and if the full high voltage is applied suddenly, the life of the high voltage rectifiers may be noticeably shortened by the repeated large surges of doubler capacitor charging current that will flow each time the high voltage is turned on.

To eliminate this effect, resistance should be put in series with the covat primary, to lower the initial voltage available at the input to the high voltage transformer. A resistor of 20 ohms will not drop the steady-state voltage noticeably if the capacitor under test is good, and yet will reduce the starting surge current through the rectifiers by as much as 75%. In addition, if the capacitor under test fails, the steady state current through the tubes will be limited to a safe value for short-time tests.

The 20 ohm resistor should be rated for at least 20 watts and should be mounted on the control panel in series with wire #9, that connects to the HIGH end of the covat input. See Fig. 9a or 9b.

7. — LOAD SURGE CURRENT LIMITATIONS:

As discussed on page 5, resistor R1 is included in the output circuit to limit the surge current available from the capacitors C3a and C3b, in case of load failure or flashover. However, the initial instantaneous current is determined (in case of NON-CAPACITATIVE LOAD ONLY) by the value of the capacitance of the output cable. This is approximately 180 mmf., and discharges in a matter of microseconds under normal flashover conditions. The instantaneous current can be very large, being determined by the flashover arc characteristics, although the energy in the cable is quite low.

If the large instantaneous current is not desired, then a surge suppressing resistor must be connected directly at the load, between the output cable connector and the load input terminal. The resistor must be designed to withstanding 30 KV surges; it is recommended that a type similar to R1 be used.

With this type of protective resistor connection, the load current must be measured, and an IR drop correction be made to the Kilovoltmeter reading, for accurate indication of the voltage applied TO THE LOAD.

SERVICE NOTES

1. — NO OUTPUT VOLTAGE READING

a. — *Low covat current or load current meter indications:*

If either of these meters reads low, and there is no high voltage output, the possibility of a short in the high voltage circuit is eliminated.

I. — Check that the output voltage meter is not open or shorted, by testing the power supply output with a Beta Electric Corp. Model 102 or 121 Kilovoltmeter, 0-30 KV DC scale. If such a meter or similar instrument is not available, check by means of drawing a spark from the high voltage lead to ground.

II. — Check the rectifiers, to see that the filaments are lit. If the filaments are on, replace the tubes, as the rectifiers may have lost emission.

III. — If rectifiers are satisfactory, check for open leads in the high voltage circuit.

IV. — If the high voltage circuit shows continuity, measure the output voltage of the high voltage transformer by means of a suitable multitester on the 5,000 volts AC range.

CAUTION: DO NOT TOUCH THE METER DURING THESE TESTS AS THE SECONDARY OF THE TRANSFORMER IS NOT GROUNDED.

If no output voltage from the AC transformer is indicated on this test, check the primary circuits for an opening in the leads going from the control circuit and the control panel to the primary of the high voltage transformer, or for an open primary in T3.

b. — *No high or low voltage, with large reading of covat current meter or load current meter:*

This indicates a short or partial short in the high voltage circuit. Check as follows:

I. — Examine the rectifiers. If both filaments are lit, then turn the output up somewhat and see if a blue glow appears in any tube. A blue glow is indicative of a gassy rectifier, which will cause a short circuit in these high voltage circuits. Replace any gassy rectifier.

If one or both of the rectifiers has a dark filament, then the filament may be burned out and shorted to the plate. Replace this rectifier and recheck operation.

II. — If the rectifiers are satisfactory, then the next possible source of difficulty is a shorted capacitor. Remove the transformer's secondary lead that goes to the smaller standoff insulator of the high voltage capacitor. Repeat the tests. If the high covat current condition is removed, then the capacitor has failed and must be replaced. If the high current condition still exists, then the fault is in the high voltage transformer, and it must be replaced.

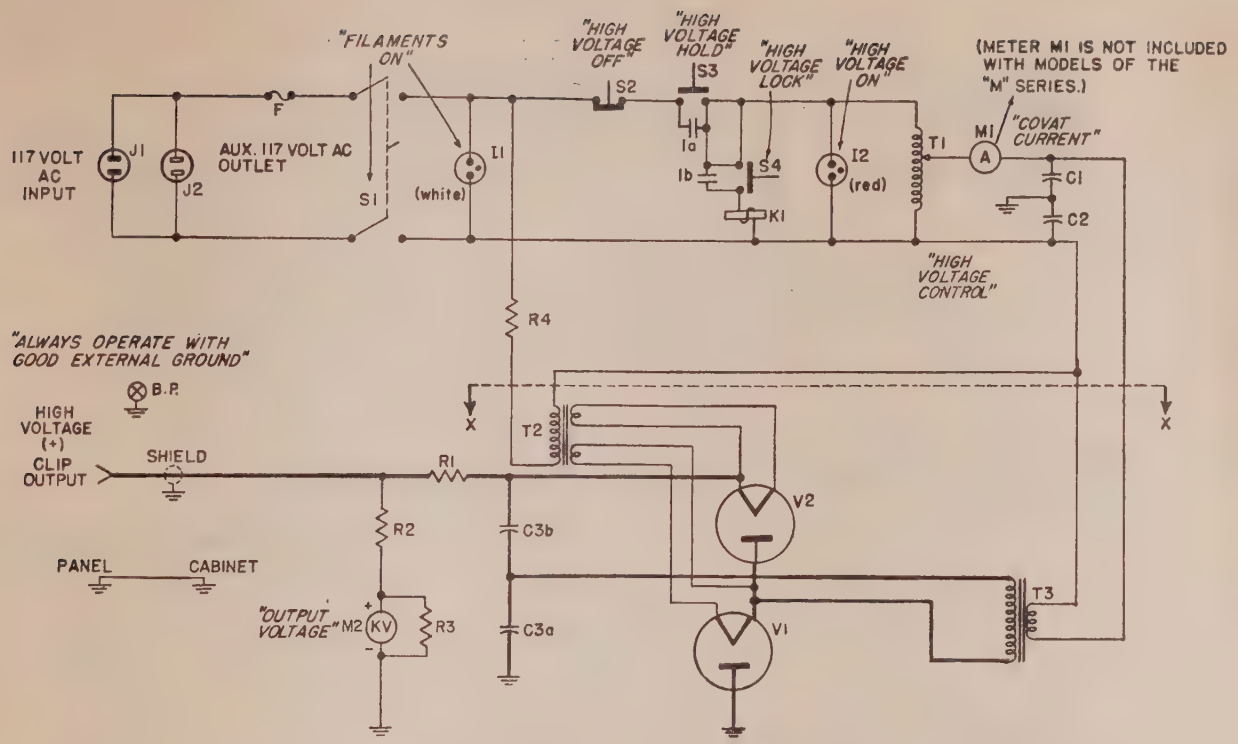
c. — *Other types of failures,* such as open multiplier resistor, open protective resistor, or open high voltage lead, will be indicated by erratic readings on the high voltage meter M2.

2. — HIGH VOLTAGE LOCK RELAY NOT PULLING IN:

If dirt accumulates on either contacts 1a or 1b, relay K1 may not pull in when the pushbuttons are depressed. Dirt can be readily removed from the contacts by running fine emery cloth across the contacts. From Fig. 9A or 9B, the location of the relay can be seen, and from Fig. 8A or 8B, can be determined the lead numbers going to the contacts that have to be cleaned.

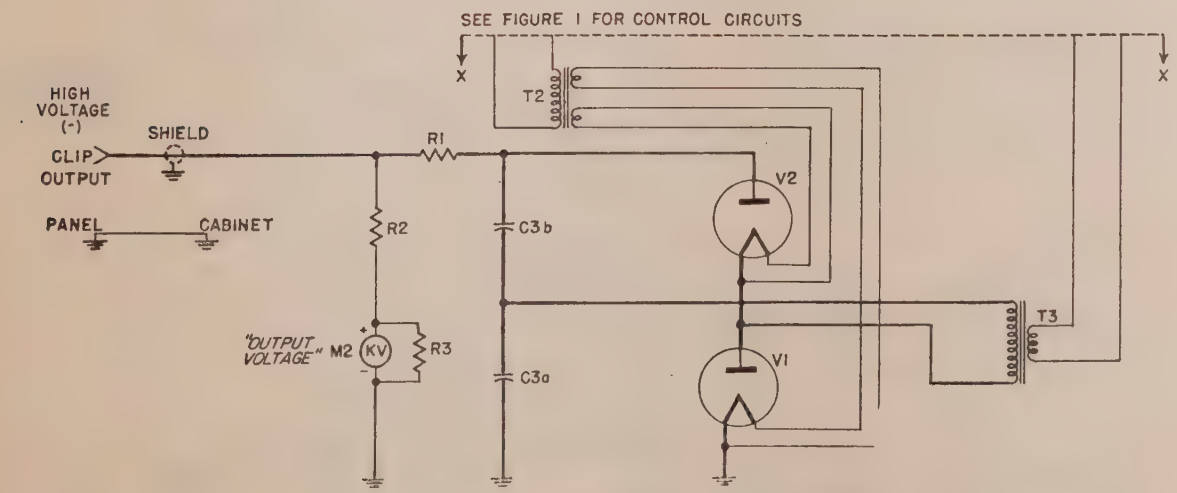
3. — CONTROL CIRCUIT FAILURES:

The operation of various control elements is straight forward, and failure of any elements should be readily detected. The basic circuit diagrams, the detailed wiring diagram, Fig. 8A or 8B, and the detailed layout diagram, Fig. 9A or 9B, should simplify all trouble shooting.



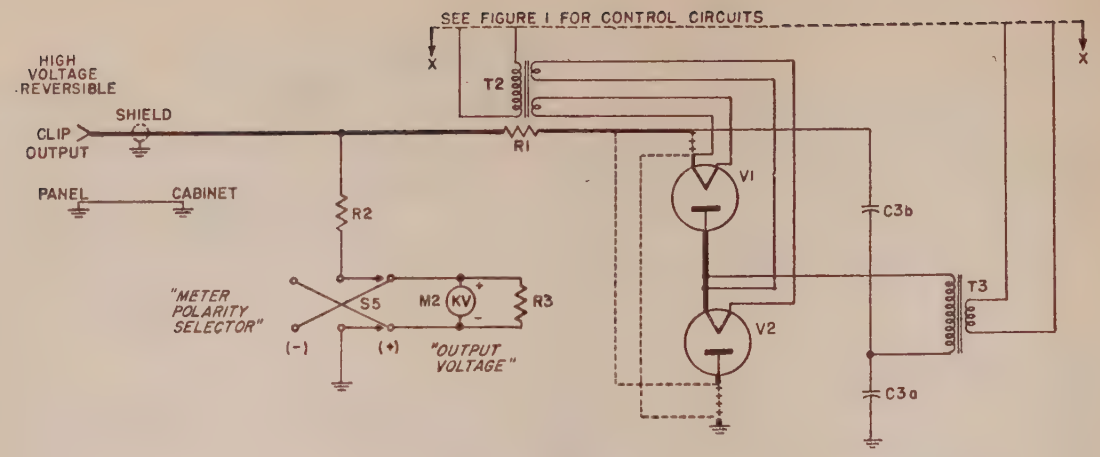
201 & 204 Schematic Circuit Diagram

Figure 1



202 & 205 Schematic High Voltage Circuit Diagram

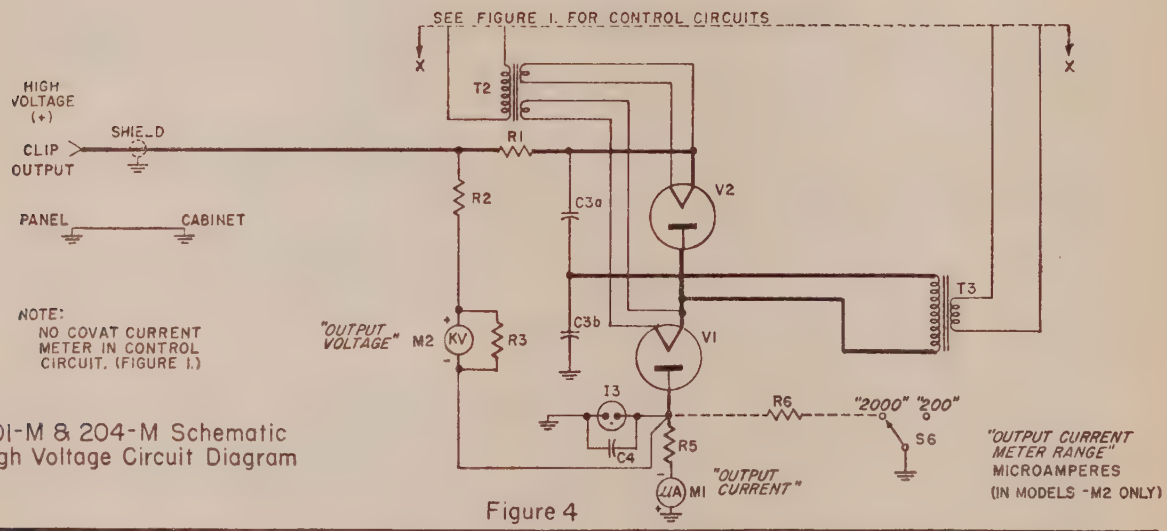
Figure 2



203 & 206 Schematic
High Voltage Circuit Diagram

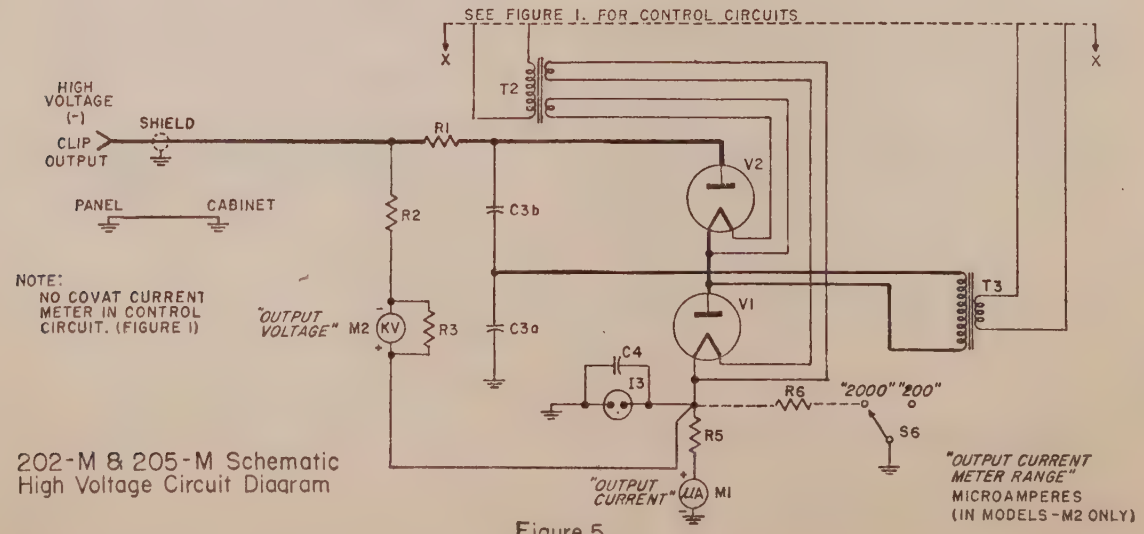
++++ CONNECTIONS FOR POSITIVE HIGH VOLTAGE
---- CONNECTIONS FOR NEGATIVE HIGH VOLTAGE

Figure 3



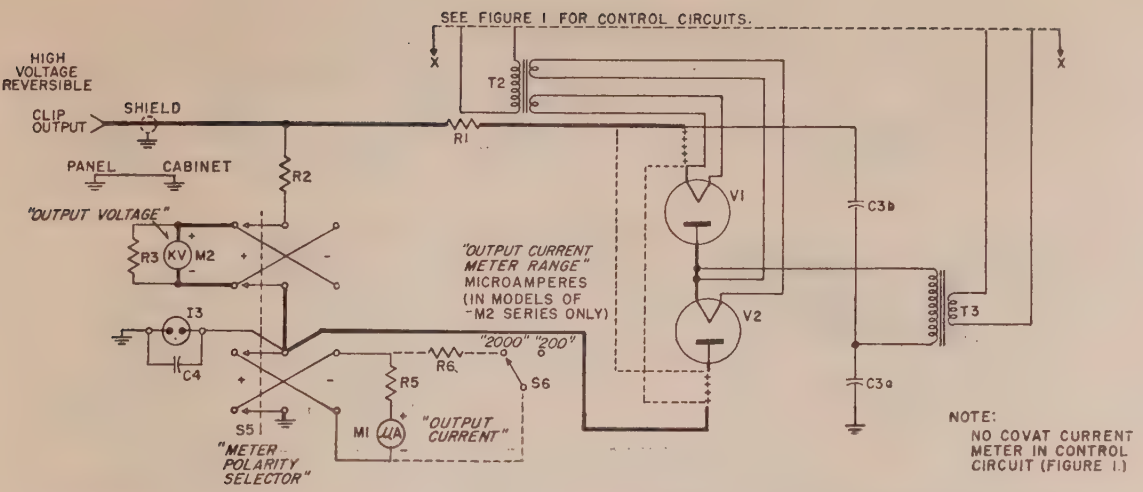
201-M & 204-M Schematic
High Voltage Circuit Diagram

Figure 4



202-M & 205-M Schematic
High Voltage Circuit Diagram

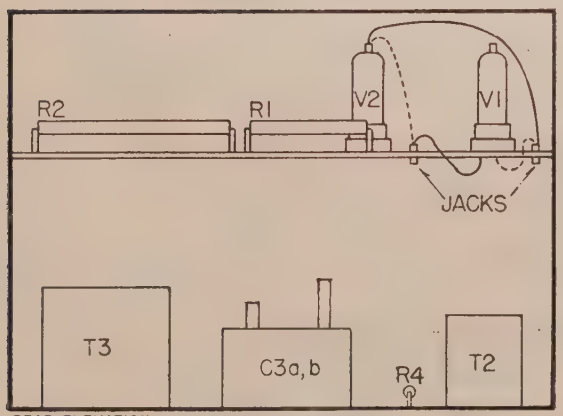
Figure 5



203-M & 206-M Schematic
High Voltage Circuit Diagram

+++++ INDICATES CONNECTIONS FOR POSITIVE HIGH VOLTAGE
---- INDICATES CONNECTIONS FOR NEGATIVE HIGH VOLTAGE

Figure 6

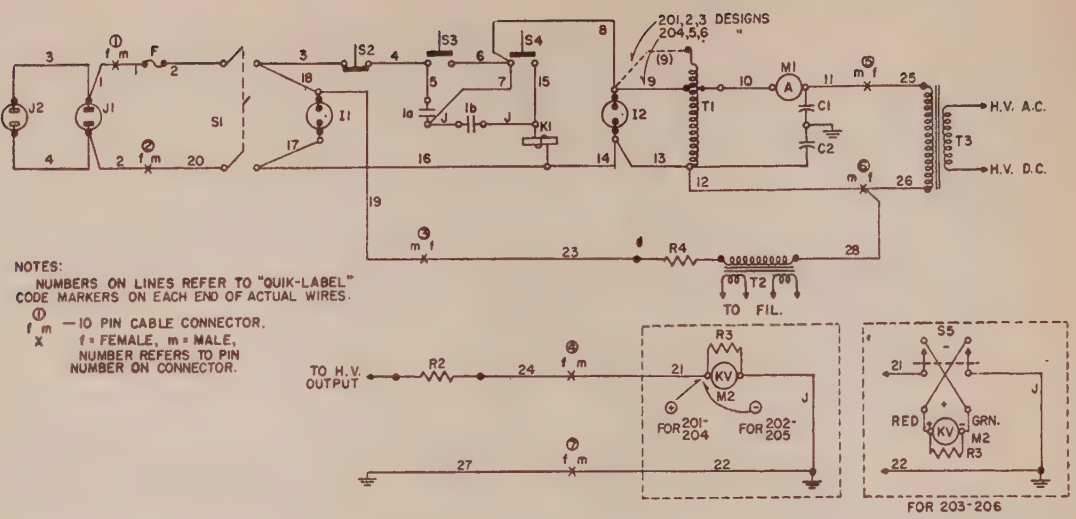


REAR ELEVATION

HIGH VOLTAGE
PARTS PLACEMENT
FOR ALL MODELS

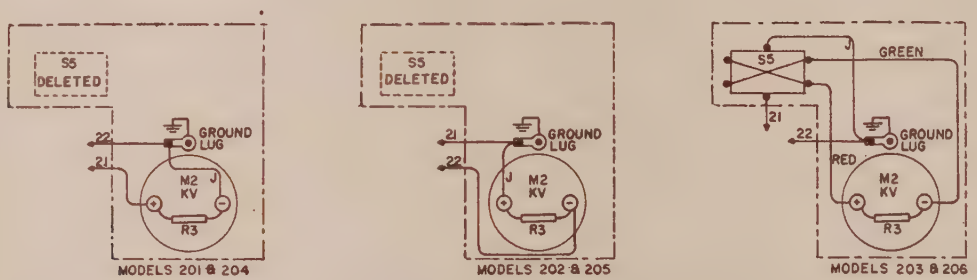
NOTE:
JACKS ARE USED IN 203 & 206 DESIGNS ONLY. SOLID LINES SHOW CONNECTIONS OF POLARITY REVERSING LEADS FOR HIGH VOLTAGE POSITIVE. DASHED LINES SHOW CONNECTIONS FOR HIGH VOLTAGE NEGATIVE.

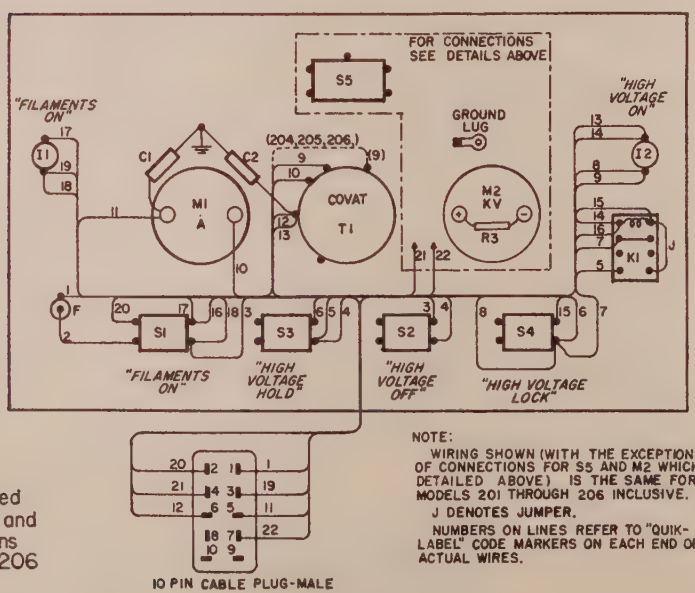
Figure 7



Detailed Wiring Diagram - Models 201-206

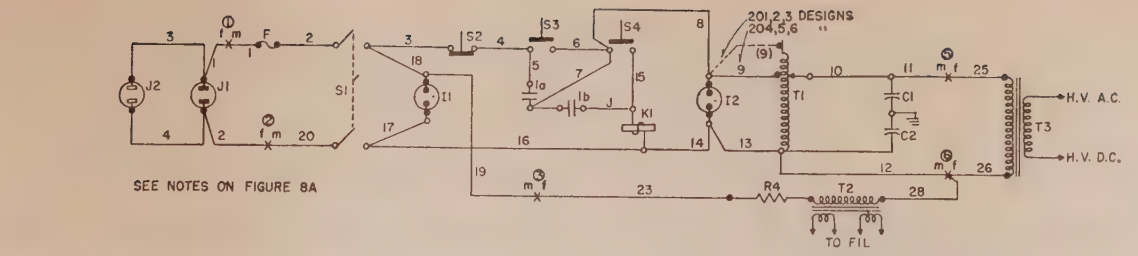
Figure 8A




FOR CONNECTIONS SEE DETAILS ABOVE
"FILAMENTS ON"
"HIGH VOLTAGE ON"
GROUND LUG
(204,205,206)
"FILAMENTS ON"
"HIGH VOLTAGE HOLD"
"HIGH VOLTAGE OFF"
"HIGH VOLTAGE LOCK"
10 PIN CABLE PLUG-MALE
NOTE:
WIRING SHOWN (WITH THE EXCEPTION OF CONNECTIONS FOR S5 AND M2 WHICH ARE DETAILED ABOVE) IS THE SAME FOR MODELS 201 THROUGH 206 INCLUSIVE.
J DENOTES JUMPER.
NUMBERS ON LINES REFER TO "QUIK-LABEL" CODE MARKERS ON EACH END OF ACTUAL WIRES.

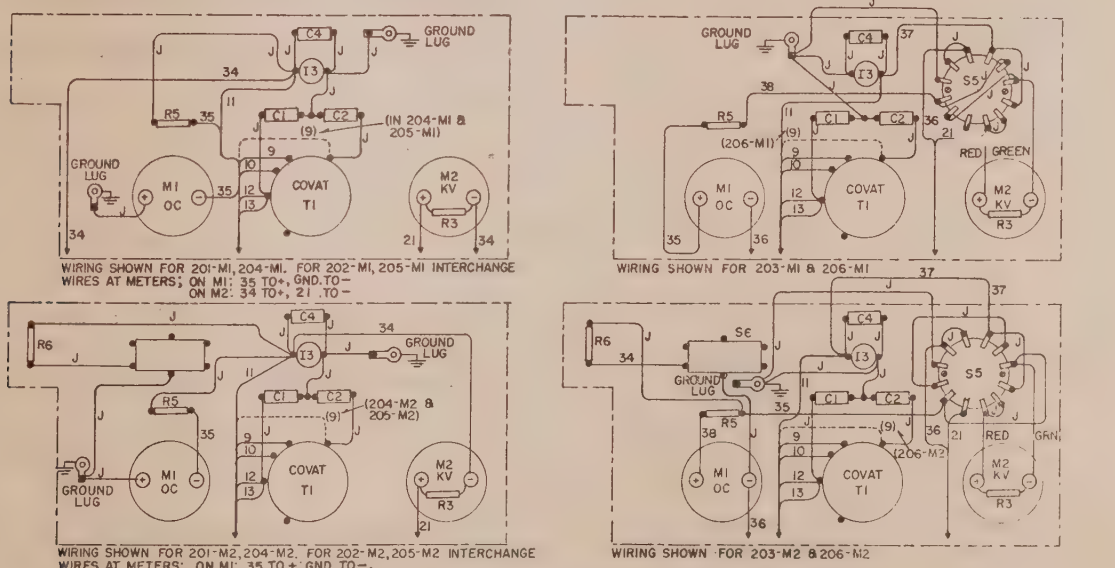
Rear Panel Detailed Parts Placement and Wiring Connections for Models 201-206

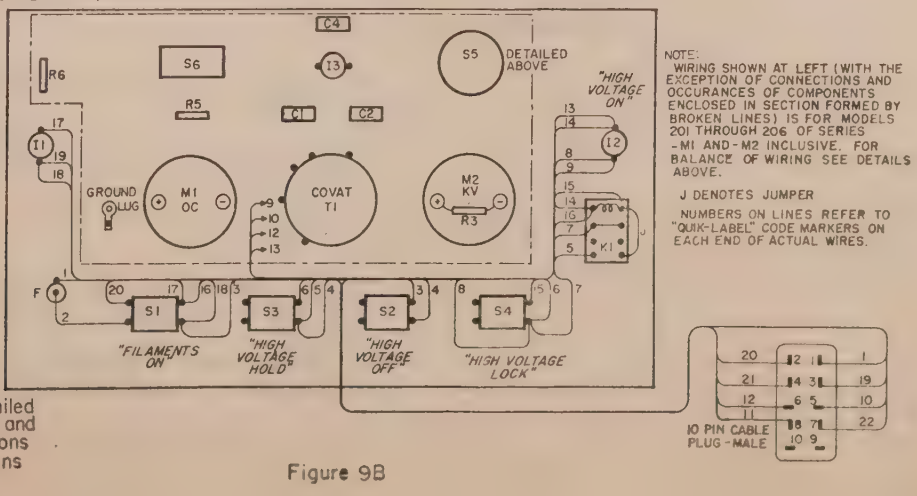
Figure 9A.


201,2,3 DESIGNS
204,5,6 "
SEE NOTES ON FIGURE 8A
H.V. A.C.
H.V. D.C.
TO FIL
TO GROUND POST ON CABINET
WIRING SHOWN IS APPLICABLE TO MODELS 201-MI,M2 202-MI & M2, 204-MI & M2, 205-MI & M2
TO PLATE-VI IN: 201-MI & 204-MI 201-M2 & 204-M2
TO CATHODE-VI IN: 202-MI & 205-MI 202-M2 & 205-M2
FOR 201, 204,-MI,-M2
FOR 202, 205,-MI,-M2
FOR: 202, 205, -MI,-M2
R6 & S6 CIRCUIT IN MODELS OF -M2 SERIES ONLY.
TO H.V. OUTPUT
TO JACK IN CABINET
WIRING SHOWN IS FOR MODELS 203-MI,-M2, 206-MI,-M2
R6 & S6 CIRCUIT IN MODELS OF -M2 SERIES ONLY

Detailed Wiring Diagram
Models 201-206,MI & -M2

Figure 8B


GROUND LUG
(IN 204-MI & 205-MI)
WIRING SHOWN FOR 201-MI, 204-MI. FOR 202-MI, 205-MI INTERCHANGE WIRES AT METERS; ON MI: 35 TO+, GND. TO− ON M2: 34 TO+, 21 TO−
(206-MI)
WIRING SHOWN FOR 203-MI & 206-MI
(204-M2 & 205-M2)
WIRING SHOWN FOR 201-M2, 204-M2. FOR 202-M2, 205-M2 INTERCHANGE WIRES AT METERS; ON MI: 35 TO +; GND. TO −. ON M2: 34 TO +, 21 TO −.
(206-M2)
WIRING SHOWN FOR 203-M2 & 206-M2


"FILAMENTS ON"
"HIGH VOLTAGE HOLD"
"HIGH VOLTAGE OFF"
"HIGH VOLTAGE LOCK"
"HIGH VOLTAGE ON"
DETAILED ABOVE
NOTE:
WIRING SHOWN AT LEFT (WITH THE EXCEPTION OF CONNECTIONS AND OCCURANCES OF COMPONENTS ENCLOSED IN SECTION FORMED BY BROKEN LINES) IS FOR MODELS 201 THROUGH 206 OF SERIES -MI AND -M2 INCLUSIVE. FOR BALANCE OF WIRING SEE DETAILS ABOVE.
J DENOTES JUMPER
NUMBERS ON LINES REFER TO "QUIK-LABEL" CODE MARKERS ON EACH END OF ACTUAL WIRES.
10 PIN CABLE PLUG - MALE

Rear Panel Detailed
Parts Placement and
Wiring Connections
for all -M Designs

Figure 9B

PARTS LIST

for Models 201, 202, 203, 204
205, 206, -M1, -M2, /R designs
Portable 0-30 KV DC Power Supply

PART DESIGNATION		DESCRIPTION
On Circuit Diagram	*Not on Circuit Diagram*	
	A1	Cabinet and rear Panel; Beta dwg. #201-CAB-P4.
	A2	Control panel; Beta dwg. #201-CP-P2.
	A3 a,b,c,d	Lucite and bakelite pieces; Beta dwg. #A3 (2 pieces of d).
	A4 (/R designs only)	Relay rack panel; Beta dwg. #201-R-A4.
C1,2		Paper molded capacitor, 0.01 mfd. 400 V dc; Micamold 339-BR110, or equivalent.
C3a,b		0.01-0.01 mfd. 16 kv dc per section; Beta #20123.
C4 (-M designs only)		0.25 mfd. 400 V dc paper; Cornell Dubilier Tiny Chief.
	E1,2	Anti-corona tube socket shield; Beta dwg. #ACS-1.
	E3	Strain relief bushing, for output cable; Heyman Manufacturing Co. #SR-7P.
	E4	Red flexible insulator, for output clip; Mueller #29, or equivalent.
E5		High voltage output clip; Mueller #27 or equivalent.
	E6,7 (Models 201, 202, 203)	3/8" steatite tube cap; National SPP-3, or equivalent.
	E6,7 (Models 204, 205, 206)	9/16" steatite tube cap; National SPP-9, or equivalent.
	E8 (Model 203, 206, only)	1¼" pointed black bakelite knob, ¼" shaft, brass insert; ICA 1274, or equivalent.
	E9 (-M2 designs only)	Per E8.
F		2 ampere, 125 volt ac fuse; Littelfuse type 3AG or equivalent.
I1,2		Neon bulb, NE 51; 115 volt ac 1/25 watt, Miniature bayonet T 3¼.
I3	(-M designs only)	Per I1,2.
J1		2 pole standard plug, recessed male receptacle; 110 V 15 A; 250 V, 10 A. Amphenol #61-M10.
J2		2 pole universal flush female receptacle; 110 V, 15 A; 250 V, 10 A. Amphenol #61F1.
J3 (Models 203, 206 only)		Banana jack; Birnbach #403.

PART DESIGNATION		DESCRIPTION
On Circuit Diagram	*Not on Circuit Diagram*	
K1		D.P.-D.T. relay; 115 V ac, 60 cycle coil; 2 ampere 115 V ac contacts. Allied type BJ6A115.
M1		0-2 amperes ac; 2½" round flush bakelite case; Simpson Electric Co. Model 155.
M1 (-M1 designs only)		0-2 milliamperes dc; 2½" round flush bakelite case. Simpson Electric Co. Model 125.
M1 (-M2 designs only)		0-200 microamperes dc; scale labelled 0-200/2000 microamperes dc; 2½" round flush bakelite case. Simpson Electric Co. Model 125.
M2		0-150 microamperes dc; Scale labeled 0-30 KV dc. 2½" round flush bakelite case; Simpson Electric Co. Model 125.
P1		10 prong Jones plug, P-310-CCT.
P2		10 prong Jones socket, S-310-CCT.
P3 (Models 203, 206 only)		Banana plug, Birnbach #401.
R1		1 meghom, 15% tolerance; Resistance Products Co. type BFQ.
R2		180 megohms, 10% tolerance; Resistance Products Co. type BFW.
R3		Wire wound calibrating resistor for kv meter; ..... ohms*.
R4 (Models, 201, 202, 203)		Ballast resistor for T2; 700 ohms, 20 watts, wire wound.
R4 (Models 204, 205, 206)		Ballast resistor for T2; 250 ohms, 20 watts, wire wound.
R5 (-M1 designs only)		22 K ohms, 1 watt carbon.
R5 (-M2 designs only)		220 K ohms, 1 watt carbon.
R6 (-M designs only)		Wire wound calibrating resistor for M1; ..... ohms**.
S1		Toggle switch; D.P.-S.T. 3 A, 125 V ac; ICA 1298 or equivalent.
S2,3,4		Pushbutton switch S.P.-D.T. 1 A. 125 V ac: ICA 1282 or equivalent.
S5 (Models 203, 206)		DP-DT rotary snap switch, 3 A at 125 V ac, Arrow, H. & H.

* This may have to be changed if R2 or M2 is replaced.

** This may have to be changed if R5, C4, or M1 is replaced.

PART DESIGNATION		DESCRIPTION
On Circuit Diagram	*Not on Circuit Diagram*	
S5 (Models 203, 206, M1, M2)		4 pole, 2 position, shorting type, Rotary selector switch; ceramic; Centralab #1408.
S6 (-M2 designs only)		S.P.-S.T. rotary snap switch, 3 A at 125 V ac; Arrow, H. & H.
T1		Covat*; 115/0-135 V, 1.5 A; General Radio type 200B Variac.
T2		117/1.6, 1.6 V at 1.5 A; 40 KV dc insulation; Beta #20112.
T3		117/11.5 KV at 4 MA RMS; start of secondary insulated for 16 kv dc; Beta #20113.
V1,2 (Models 201, 202, 203)		1B3 rectifier tube.
V1,2 (Models 204, 205, 206)		5825 rectifier tube.
W1		RG 8/U cable.
	W2	Line cord, 6 ft. long. G.E. #2118 SJ.
BP		Vise grip ground binding post; ICA 631 or equivalent.
	XF	Fuse holder assembly, Bussman type HKP.
	XI1	Neon pilot light assembly, clear faceted lens, DIALCO 81408-437.
	XI2	Neon pilot light assembly, red faceted lens, DIALCO 81408-431.
	XI3 (-M designs only)	Neon pilot light assembly, clear faceted lens without resistor in base; DIALCO #810B-437.
	XV1,2 (Models 201, 202, 203)	Octal breadboard socket, EBY 12-8 (no equivalent).
	XV1,2 (Models 204, 205, 206)	4 prong breadboard socket, EBY 12-4 (no equivalent).

* See note, page 3.